

What is claimed is:

- 1 1. A reflector structure in a liquid crystal display having light condensing effect,  
2 comprising:  
3 a condenser having diffraction or refraction condensing effect, said condenser having  
4 an averaged equivalent focus;  
5 a spacing layer being formed above and covering said condenser, said spacing layer  
6 having a thickness; and  
7 a reflective unit formed above said spacing layer.
- 1 2. The reflector structure in a liquid crystal display having light condensing effect as  
2 claimed in claim 1, wherein said reflector structure further includes an active device  
3 substrate formed above said condenser
- 1 3. The reflector structure in a liquid crystal display having light condensing effect as  
2 claimed in claim 1, wherein said spacing layer is an active device substrate.
- 1 4. The reflector structure in a liquid crystal display having light condensing effect as  
2 claimed in claim 1, wherein said condenser has diffraction or refraction condensing  
3 effect and comprises a plurality of several metals with periodic patterns and various  
4 widths and distances.
- 1 5. The reflector structure in a liquid crystal display having light condensing effect as  
2 claimed in claim 1, said condenser further comprising:  
3 a first layer of transparent materials with unit refractive index, said first layer of  
4 transparent materials comprising a plurality of transparent materials with periodic

- 5 patterns and various widths and distances; and
- 6 a second layer of transparent materials with different refractive index, said second
- 7 layer being formed above said first layer of transparent materials.
- 1 6. The reflector structure in a liquid crystal display having light condensing effect as
- 2 claimed in claim 1, said condenser further comprising:
- 3 a first layer of transparent materials with unit refractive index, said first layer of
- 4 transparent materials comprising a plurality of multi-level transparent materials with
- 5 periodic patterns and various distances; and
- 6 a second layer of transparent materials with different refractive index, said second
- 7 layer being formed above said first layer of transparent materials.
- 1 7. The reflector structure in a liquid crystal display having light condensing effect as
- 2 claimed in claim 1, said condenser further comprising:
- 3 a first layer of transparent materials with unit refractive index, said first layer of
- 4 transparent materials comprising a plurality of wedge-shaped micro prisms of unit
- 5 refractive index with periodic patterns and various distances; and
- 6 a second layer of transparent materials with different refractive index, said second
- 7 layer being formed above said first layer of transparent materials.
- 1 8. The reflector structure in a liquid crystal display having light condensing effect as
- 2 claimed in claim 1, said condenser further comprising:
- 3 a first layer of transparent materials with unit refractive index, said first layer of
- 4 transparent materials comprising a plurality of micro lens of unit refractive index with
- 5 periodic patterns and various distances; and

6 a second layer of transparent materials with different refractive index, said second  
7 layer being formed above said first layer of transparent materials.

1 9. The reflector structure in a liquid crystal display having light condensing effect as  
2 claimed in claim 6, wherein the cross sectional shapes of said multi-level transparent  
3 materials are rectangular and the widths of rectangular transparent materials are  
4 decreased level by level from bottom to top.

1 10. The reflector structure in a liquid crystal display having light condensing effect as  
2 claimed in claim 6, wherein said second layer of transparent materials is a spacing  
3 layer.

1 11. The reflector structure in a liquid crystal display having light condensing effect as  
2 claimed in claim 7, wherein said plurality of wedge-shaped micro prisms have  
3 various sizes including volumes, cross-sectional or lateral areas, slopes and heights.

1 12. The reflector structure in a liquid crystal display having light condensing effect as  
2 claimed in claim 8, wherein said plurality of micro lens have various sizes including  
3 volumes, cross-sectional or lateral areas, slopes and heights.

1 13. The reflector structure in a liquid crystal display having light condensing effect as  
2 claimed in claim 7, wherein said second layer of transparent materials is a spacing  
3 layer.

1 14. The reflector structure in a liquid crystal display having light condensing effect as  
2 claimed in claim 8, wherein said second layer of transparent materials is a spacing  
3 layer.

1 15. The reflector structure in a liquid crystal display having light condensing effect as

2 claimed in claim 1, wherein the range of the averaged equivalent focus of said  
3 condenser is 230  $\mu\text{m}$  to 1250  $\mu\text{m}$ .

1 16. The reflector structure in a liquid crystal display having light condensing effect as  
2 claimed in claim 1, wherein said spacing layer is an over coat layer.

1 17. The reflector structure in a liquid crystal display having light condensing effect as  
2 claimed in claim 1, wherein said spacing layer is a color filter.

1 18. The reflector structure in a liquid crystal display having light condensing effect as  
2 claimed in claim 2, said spacing layer further comprising:

3 a color filter formed above said condenser; and

4 an over coat layer formed above said color filter.

1 19. The reflector structure in a liquid crystal display having light condensing effect as  
2 claimed in claim 1, wherein the ratio of the averaged equivalent focus of said  
3 condenser to the thickness of said spacing layer is between 0.65 and 1.4.

1 20. The reflector structure in a liquid crystal display having light condensing effect as  
2 claimed in claim 2, where said reflective unit is a flat metal layer.

1 21. The reflector structure in a liquid crystal display having light condensing effect as  
2 claimed in claim 2, said reflective unit further comprising:

3 an inner diffusion layer formed above said spacing layer, said inner diffusion layer  
4 forming convex structures around the pixel and within the pixel area of said liquid  
5 crystal display and concave structures at the boundary of the transparent area, the  
6 average gap of liquid crystal cells in the transparent area is different from the average  
7 gap of liquid crystal cells in the reflective area within a single pixel area;

8 a reflective metal layer formed above said inner diffusion layer in the reflective area  
9 of said liquid crystal display; and

10 an ITO electrode layer formed above said spacing layer in the transparent area of said  
11 liquid crystal display.

1 22. The reflector structure in a liquid crystal display having light condensing effect as  
2 claimed in claim 21, said spacing layer further comprising:

3 a color filter formed above said condenser; and

4 an over coat layer formed above said color filter.

1 23. The reflector structure in a liquid crystal display having light condensing effect as  
2 claimed in claim 21, wherein said spacing layer is a color filter.

1 24. The reflector structure in a liquid crystal display having light condensing effect as  
2 claimed in claim 2, said reflective unit further comprising:

3 an inner diffusion layer formed above said spacing layer, said inner diffusion layer  
4 having only one gap of liquid crystal cells within a single pixel area;

5 a reflective metal layer formed above said inner diffusion layer in the reflective area  
6 of said liquid crystal display; and

7 an ITO electrode layer formed above said spacing layer in the transparent area of said  
8 liquid crystal display.

1 25. The reflector structure in a liquid crystal display having light condensing effect as  
2 claimed in claim 21, wherein said ITO electrode layer has at least one aperture.

1 26. The reflector structure in a liquid crystal display having light condensing effect as

2 claimed in claim 3, said reflective unit further comprising:  
3 an inner diffusion layer formed above said active device substrate, said inner  
4 diffusion layer forming convex structures around the pixel and within the pixel area  
5 of said liquid crystal display and concave structures at the boundary of the transparent  
6 area, the average gap of liquid crystal cells in the transparent area is different from the  
7 average gap of liquid crystal cells in the reflective area within a single pixel area;  
8 a reflective metal layer formed above said inner diffusion layer in the reflective area  
9 of said liquid crystal display; and  
10 an ITO electrode layer formed above said active device substrate in the transparent  
11 area of said liquid crystal display.

1 27. The reflector structure in a liquid crystal display having light condensing effect as  
2 claimed in claim 3, said reflective unit further comprising:  
3 an inner diffusion layer formed above said active device substrate, said inner  
4 diffusion layer having only one gap of liquid crystal cells within a single pixel area;  
5 a reflective metal layer formed above said inner diffusion layer in the reflective area  
6 of said liquid crystal display; and  
7 an ITO electrode layer formed above said active device substrate in the transparent  
8 area of said liquid crystal display.

1 28. The reflector structure in a liquid crystal display having light condensing effect as  
2 claimed in claim 3, said reflective unit in each of red, green and blue sub-pixel areas  
3 in a single pixel area further comprising:  
4 an inner diffusion layer formed above said active device substrate, said inner

5 diffusion layer forming convex structures around the pixel and within the pixel area  
6 of said liquid crystal display and concave structures at the boundary of the transparent  
7 area, the average gap of liquid crystal cells in the transparent area is different from the  
8 average gap of liquid crystal cells in the reflective area within a single pixel area;  
9 a reflective metal layer formed above said inner diffusion layer in the reflective area  
10 of said liquid crystal display;  
11 a first ITO electrode layer formed above said active device substrate in the transparent  
12 area of said liquid crystal display;  
13 a color filter formed above said inner diffusion layer, said reflective metal layer, and  
14 said first ITO electrode layer; and  
15 a second ITO electrode layer formed above said color filter.

1 29. A liquid crystal display having light condensing effect with a reflector structure as  
2 claimed in claim 1, wherein said liquid crystal display further comprises an upper  
3 plate and a layer of liquid crystal cells, and said upper plate includes from top to  
4 bottom an upper substrate, a color filter and a layer of ITO electrode layer.

1 30. The liquid crystal display having light condensing effect as claimed in claim 29, said  
2 liquid crystal display comprising the reflector structure having light condensing effect  
3 as claimed in claim 28.

1 31. The liquid crystal display having light condensing effect as claimed in claim 29, said  
2 liquid crystal display comprising the reflector structure having light condensing effect  
3 as claimed in claim 22.

1 32. The liquid crystal display having light condensing effect as claimed in claim 29, said

2 liquid crystal display comprising the reflector structure having light condensing effect  
3 as claimed in claim 23.

1 33. The liquid crystal display having light condensing effect as claimed in claim 29,  
2 wherein liquid crystal cells in said liquid crystal layer are positive or negative liquid  
3 crystals.

1 34. The liquid crystal display having light condensing effect as claimed in claim 29,  
2 wherein the liquid crystal gap in the transparent area of said liquid crystal layer is  
3 greater than that in the reflective area.

1 35. The liquid crystal display having light condensing effect as claimed in claim 34,  
2 wherein the difference between the liquid crystal gap in the transparent area and the  
3 liquid crystal gap in the reflective area is between 0.16  $\mu\text{m}$  and 3.3  $\mu\text{m}$ .

1 36. The liquid crystal display having light condensing effect as claimed in claim 34,  
2 wherein liquid crystal cells in said liquid crystal layer are positive liquid crystals, and  
3 the bi-refractive index of said positive liquid crystals is between 0.05 and 0.1.

1 37. The liquid crystal display having light condensing effect as claimed in claim 34,  
2 wherein liquid crystal cells in said liquid crystal layer are positive liquid crystals, the  
3 range of the retardation in the transparent area is 270 nm to 460 nm, and the range of  
4 the retardation in the reflective area is 200 nm to 330 nm.

1 38. The liquid crystal display having light condensing effect as claimed in claim 34,  
2 wherein liquid crystal cells in said liquid crystal layer are negative liquid crystals, and  
3 the bi-refractive index of said negative liquid crystals is between 0.06 and 0.13.

1 39. The liquid crystal display having light condensing effect as claimed in claim 34,



2 wherein liquid crystal cells in said liquid crystal layer are negative liquid crystals, the  
3 range of the retardation in the transparent area is 320 nm to 500 nm, and the range of  
4 the retardation in the reflective area is 150 nm to 400 nm.

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